PROPER AUTOMOTIVE WASTE MANAGEMENT

STUDENT WORKBOOK

INTEGRATED WASTE MANAGEMENT BOARD

October 2003

Zero Waste—You Make It Happen!

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Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, **Flex Your Power** and visit
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Manual Production

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INTRODUCTION

This workbook provides a comprehensive outline of the Instructors' Resource Manual to allow you, as automotive students, to have an overall picture of how the course is organized. There are student activities and exercises to be completed as part of this instructional package.

The activities and exercises are organized into two sections:

1. Cognitive Activities
2. Hands-On Activities

Handouts are included that will assist you in taking notes as the instructor presents the material. These handouts provide an excellent review of the course material.

COURSE OUTLINE

The following is the outline of the entire Proper Automotive Waste Management Resource Manual. You now have access to how the course is organized and you have the opportunity to discover the wide variety of topics covered.

Instructor's Resource Manual

Problems (Challenges and Barriers)
Solutions
Liquid Waste
Solid Waste
Gaseous Waste
Appendices
Glossary of Terms
Links
References

COGNITIVE ACTIVITIES

Complete these cognitive activity sheets as you are engaged in the various exercises. Be sure to read any materials your instructor has previously assigned. The better prepare you are the more you will learn and will benefit from this course. These cognitive exercises are intended to start you thinking creatively about pollution prevention and waste management. Enjoy your work.

The cognitive activities are as follows:

Basics in Cleaning the Shop
Dealing with Waste
Earth's Resources Found in the Auto Shop
How Oil Is Formed #1
How Oil Is Formed #2
It's Up to You
Motor Oil
Removing Oil from the Earth
Throwing Oil in the Trash
Used Oil and You

BASICS IN CLEANING UP THE SHOP

The following practices and equipment significantly reduce the amount of water needed to clean shop floors, especially when used together. Less "waste water" means fewer possible environmental problems caused by the wastes in the water.

Objectives

- To learn how to reduce water needed for shop cleanup.
- To clean up the shop correctly.

Exercise

Move into your groups and create additional shop practices other than the ones listed. Think of practices that could be used to reduce waste and promote proper cleanup. Share these with the rest of the class and discuss placing them into the everyday shop routine. Would any of the practices be hard to follow routinely? Why? Why not?

How to help keep the shop clean

- Prevent spills from ever reaching the floor!

- Stop if there's a drop! Never walk away from a spill.
  Why? If spills are not cleaned up immediately....

  1. Workers can slip and fall causing injury.
  2. Oil, antifreeze, and other spilled material can mix and be tracked around shop and vehicles, causing contamination.
  3. More time and money will have to be spent cleaning up the floor and other contaminated areas.

- Carry rags so that the small spills can be wiped dry when they occur. *Never* saturate rags with liquids! Waste haulers may not pick up rags with "free liquid." Always use enough rags to prevent saturation of any.

- Use the “4-step method: to clean up spills:

    1. Use a “hydrophobic” mop to pick up oil from any spill.
    2. Use “dedicated mops” (that is, one for coolant, one for oil, and a third for wash water).

    3. Use shop rags to pick up residual liquid.

    4. Wet mop, if necessary, with a mild non-caustic detergent as a final cleanup. Empty the wash water into the sanitary sewer through a sink or toilet, *never* into storm drains!

- Cleanup equipment should be well marked. For example, attach red flags to mop buckets used for spill cleanup so workers can easily locate them. Keep ***all*** spills out of storm drains!

- *Absolutely never* hose down the work area!! This generates large quantities of contaminated wash water that is discharged into sewers, or worse, is flushed out of the shop and into a storm drain.

- If a pressure washer is used to clean your shop floors, be sure to dispose of the wash water properly. Even if a contractor performs the pressure washing, the shop is responsible for proper management of the wash water and can be held liable for its illegal disposal.

Consider this:

Sealing the shop floor with an epoxy or other suitable sealant.

An epoxy-sealed floor...

- Won't absorb spills as a concrete floor does.

- Makes spill cleanup easier. (Squeegee small spills into a dustpan and pour the liquid into the appropriate container.)

- Requires less time and water to clean.

- Lasts for years and reduces long-term liability for cleanup of a contaminated shop floor and soil below.

Storage

Store all of your hazardous liquids in covered containers to prevent evaporation, spills, and contamination. Make sure all storage units are locked and roofed or are covered indoor areas with concrete flooring and curbs for spill containment.

Organize storage areas with enough room for easy and safe access. Inspect the storage area at least once a week for leaky containers, spills, leaks, and out-of-date supplies.

Control that Spill!

Help reduce spills by using a gravity spigot or pump to dispense bulk liquid materials. Always use a spout and funnel when transferring liquids. Keep lids on containers at all times except when in use.

Note: Check with your sewer utility to find out where the wastewater from your drains ends up. Most outside drains and some inside drains do not lead to sewage treatment plants, but are actually storm drains that lead directly to a stream, lake, ditch or to dry wells. Discharging contaminated water into any of these may pollute surface and/or ground water and result in significant fines and environmental damage.

Wastewater Contamination

If you can contain and clean up all leaks and spills without a discharge of wastewater to either the either sanitary sewer or storm drain, then you may not need to monitor waste water discharges. Use procedures and equipment that recycle rinse and wash water.

Collect leaking or dripping fluids in drip pans or containers. Keep a drip pan under the vehicle while you unclip hoses, unscrew filters, or remove other parts. Drain and replace motor oil, coolant, and other fluids in a designated area of the shop, where the storm and/or sanitary sewer floor drains are protected. Clean up minor spills before they reach the drains.

Be sure to recycle because if you do not, you may have to dispose of fluids as hazardous wastes, which can mean higher costs for you and the environment.

DEALING WITH WASTE

Objective

- To learn how to manage waste correctly.

Exercise

Move into groups and discuss different ideas about how waste can be reduced as well as managed.

Look around the shop you currently work in and note areas that need to be improved to better manage waste.

Discuss these ideas with the rest of the class and with your group develop an action plan to make those improvements within the shop.

Why Properly Manage Waste?

One of the hidden roles of automotive repair employees is the protection of public heath and the environment through proper waste management practices. By maintaining these practices, you also allow your business to:

- Save money through reduction or recycling of wastes.
- Stay in compliance with local, State, and federal environmental regulations and avoid costly penalties.
- Gain customers who prefer to deal with a shop that acts in an environmentally responsible manner.
- Join other automotive repair shops in your area that take pride in maintaining a clean and healthy environment.

An automotive fluids management program will reduce costs, paperwork, liabilities, and the production of pollution if auto shop managers take the following steps:

- Promote inclusion of all staff in processes and rewards.
- Enhance employee communication about pollution prevention benefits.

- Establish a company policy of pollution prevention.
- Identify ways to reduce or eliminate automotive fluids waste.
- Instill a philosophy of proper health and safety practices.

Participation and Proper Handling of Wastes

Demonstrated upper management support of a proposed Pollution Prevention program is crucial to its acceptance by "line" employees. Management must establish waste minimization as a top priority in the hierarchy of a company's business goals. Everyone in the auto shop needs to understand and be able to implement the following waste handling and minimization practices:

- Keep all product and waste chemicals in sealed containers with tight-fitting lids.
- Keep solvent rags in a closed container when not being used.
- Keep lids on all solvents and turn off your solvent sink when not in use. Solvent losses due to evaporation, equipment leaks, or spills and inappropriate usage can range from 25 to 40 percent.
- Be aware that, when mixed with hazardous substances (for example, chlorinated solvents), otherwise safe products may need to be handled as hazardous wastes.
- Do not allow cleaning solutions to enter the sewer system unless you have approval from the wastewater treatment plant.
- Never discharge any waste to a street, ditch, storm sewer, stream or the ground.
- Review the need to clean parts and the degree of cleaning needed. Perhaps not all cleaning that is done is necessary.

Possible Ideas for Reducing Waste

- Switch to a re-circulating aqueous spray cabinet for cleaning parts instead of using solvents or hot tanks. This can reduce the volume of hazardous waste that requires disposal.
- Use dirty solvent first when cleaning parts, rather than fresh solvent. In addition, use a filter on parts washers to extend the life of the solvent.

- Consider switching to water-based or steam cleaners instead of using spray cans of brake cleaners, carburetor cleaner, or solvent parts cleaners.

Source Reduction

Source reduction is not as difficult as some might think. By simply walking through the shop and taking note of all processes that generate wastes, one can determine which wastes are most likely to be toxic or hazardous. Look at each process in the shop and determine if it can be modified in some way to limit the production of hazardous waste.

- Don't stockpile perishable supplies. Label, date, and inspect new materials as they are received, and use the oldest stock first. Keep records of dates of receipts and usage to help reduce overstock and material degradation.

- Purchase supplies in bulk and keep them in bulk dispensers. This eliminates empty waste containers that may need to be disposed of as hazardous waste.

- Keep on hand only the quantities of materials that you really need and use them on a "first-in first-out" basis, to avoid the need to discard unopened cans when the material's shelf life expires.

- Consider reducing the number of different brands or grades of materials that you use; this will reduce the number of containers you keep in storage and reduce the risk and severity of fire or accident.

- Select suppliers who will allow you to return used materials and containers for recycling.

- Share unwanted materials.

Dealing with Waste that Cannot be Reduced or Reused

- Contract for a recycling service to pick up used antifreeze, lead-acid batteries, motor oil, oil filters, solvents, and scrap tires.

- Consider an on-site distillation unit to recycle used solvents and engine coolant.

- Fleet maintenance shops should consider using retread tires, re-refined motor oil, and engine oil analysis as means of reducing costs and reducing waste generation.

- Use an oil separator and water recycling system for the wash rack to reduce water usage and wastewater disposal.

Recycle

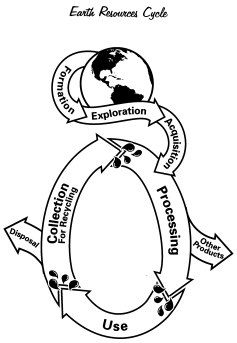
When the process of reusing and reducing is not an option, then recycle wastes whenever possible.

EARTH'S RESOURCES FOUND IN THE AUTO SHOP

Objective

- To understand the resources needed to produce various products.

Exercise



Find three objects in the shop that are used on a weekly basis and determine the following about each object:

- The components that make up the object.
- The Earth resources used in each object.
- The source or origin of those resources.
- Whether the resources are renewable or non-renewable.

Note: Renewable resources are Earth resources that are replaced naturally within a human lifetime. Non-renewable resources are Earth resources that cannot be replace naturally within a human lifetime.

Example Chart

Object: Pencil

Components	Earth Resources	Source/Origin	Renewable or Non-renewable
Wood	Trees	Seeds	Renewable
Graphite	Mineral ores	Earth's crust	Non-renewable
Paint	Crude oil	Decomposing plankton	Non-renewable
Rubber	Rubber plants	Seeds	Renewable
Metal	Mineral ores	Formed by cooling magma	Non-renewable

Discussion

Fill out the attached chart with your own findings.

Gather in groups of two or three and share your results and then present them to the class.

Object:_____

Components	Earth Resource	Source/ Origin	Renewable or Non-renewable

Object:_____

Components	Earth Resource	Source/ Origin	Renewable or Non-renewable

Object:_____

Components	Earth Resource	Source/ Origin	Renewable or Non-renewable

How Oil is Formed #1

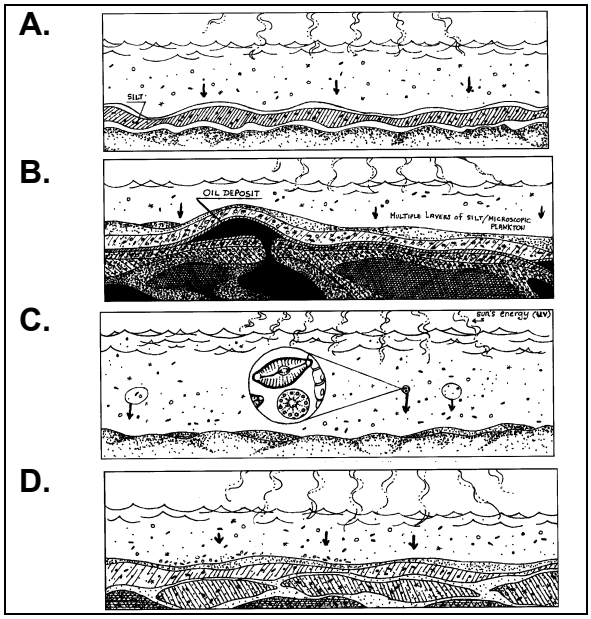
Oil that is used today was formed from the decomposition of marine organisms. Tiny organisms that lived in the sea died and settled to the bottom of the ocean. Soon deposits of silt, mud and fine sand settled on top of them. This process continued causing pressure to build up on the deposits and the temperature to increase. The mud, sand and silt hardened and the remains of the dead organisms were converted into hydrocarbon molecules or crude oil.

Objective

- To understand how oil is formed.

Exercise

The text below and the pictures to the right are out of sequence. In what order should they be rearranged?



1. Many layers of sediment form.
2. Microscopic plankton dies and sinks to bottom of the ocean.
3. Carbon compounds rearrange to form hydrocarbon molecules of oil and natural gas.
4. Sediments bury the dead plankton quickly.
5. Heat and pressure on decomposed material increase.
6. Microbes decompose dead plankton.

Directions

Place each statement number and picture letter in the correct order. Note: Not all statements are accompanied by a picture.

Order	Statement #	Picture
1st		
2nd		
3rd		
4th		
5th		
6th		

HOW OIL IS FORMED #2

Objective

- To understand how oil is formed.

Exercise

Using the Geological Time Chart, answer the following questions:

Write the stages of crude oil formation.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

Read and carefully study the geological time chart, then answer the following questions:

1. What was the first time period in which algae and small animals became plentiful in the oceans?

_____

_____

2. What geological formations were developing in this same time period?

_____

_____

_____

3. How are the formation and location of crude oil specifically selected to geologic processes?

4. Why is it a myth that crude oil was formed from dinosaur remains?

5. What can you conclude or summarize about the origin of crude oil?

6. Write a question beginning with “How” or “Why” related to the geological time chart and then write the answer for it.

Answer:

7. Is it possible that there is oil forming today? Explain your answer.

GEOLOGICAL TIME CHART

The Earth's earliest history appears at the bottom of the chart, and its most recent history is at the top.

		Period or Epoch and Its Length	Beginning (Years Ago)	Development of Life on Earth		Development of the Earth
CENOZOIC ERA	Quaternary Period	**Holocene Epic** 11 1/2 Thousand Years	11 1/2 Thousand	Humans hunted and tamed animals; developed agriculture; learned to use metals, coal, oil, gas, and other resources; and put the power of the wind and rivers to work.	 Cultivated Plants	Streams, glaciers, and oceans eroded the land. Present river deltas and coastlines were formed. Ice Age glaciers melted and water collected, forming the Great Lakes of North America.
		Pleistocene Epoch 2 Million Years	2 Million	Modern humans developed. Mammoths, woolly rhinos, and other animals flourished but died out near the end of the epoch.	 Human Beings	Several times during the Ice Age, glaciers covered large areas of North America and Europe. The climate was cool. Mountains rose in western North America, and volcanoes erupted.
	Tertiary Period	**Pliocene Epoch** 3 Million Years	5 Million	Sea life became much like that of today. Birds and many mammals became like modern kinds and spread throughout the world. Humanlike creatures appeared.	 Horses	The Oligocene, Miocene, and Pliocene epochs were much alike. Rocks that formed during these epochs included clays, limestones, and sands. The climate was uniform and mild through the Oligocene and Miocene, but began to get cooler during the Pliocene, leading up to the following Ice Age. Mountain making was common, and many volcanoes erupted. Oil and natural gas formed in rocks made during these epochs.
		Miocene Epoch 19 Million Years	24 Million	Apes appeared in Asia and Africa. Other animals included bats, monkeys, and whales, and primitive bears, and raccoons. Flowering plants and trees resembled modern kinds.	 Apes	
		Oligocene Epoch 14 Million Years	36 Million	Primitive apes appeared. Camels, cats, dogs, elephants, horses, rhinos, and rodents developed. Huge rhinoceros-like animals disappeared near the end of the epoch.	 Early Horses	
		Eocene Epoch 17 Million Years	55 Million	Fruits, grains, and grasses developed. Birds, amphibians, small reptiles, and fish were plentiful. Primitive bats, camels, cats, horses, monkeys, rhinoceroses, and whales appeared.	 Grasses	Seas flooded the shores of the continents. Large areas were covered by swamps where lignite, a kind of coal, later formed. Oil and gas also formed in clays, limestones, and sands.
		Paleocene Epoch 10 Million Years	65 Million	Flowering plants became plentiful. Invertebrates, fish, amphibians, reptiles, and small mammals were common.	 Small Mammals	Thick soil formed in hot, rainy lands. Mountains, not yet worn by erosion, were high. The climate was varied. Coal, gas, and oil formed in clays, limestones, and sands.
MESOZOIC ERA		**Creataceous Period** 73 Million Years	138 Million	Flowering plants appeared. Invertebrates, fish, and amphibians were plentiful. Many fish resembled modern kinds. Dinosaurs with horns and armor became common. Dinosaurs died out.	 Flowering	Oceans flooded large areas. Cool swamps developed. Rocks included chalk, limestones, sandstones, and shales. Gas, oil, and ores of gold and other metals were formed.
		Jurassic Period 67 Million Years	205 Million	Cone-bearing trees were plentiful. Sea life included shelled squid. Dinosaurs reached their largest size. The first birds appeared. Mammals were small and primitive.	 Birds	Shallow seaways cut across the continents. Some volcanic action occurred. Rocks included limestones, sandstones, and shales. Gas, oil, salt, and ores of gold and uranium formed.
		Triassic Period 35 Million Years	240 Million	Cone-bearing trees were plentiful, as were fish and insects. The first turtles, crocodiles, and dinosaurs appeared, as did the first mammals.	 Dinosaurs	Layers called *red beds* developed along with shales, sandstones, and limestones. Gas, oil, and ores of copper and uranium formed. Faults (cracks) occurred in eastern North America.
PALEOZOIC ERA		**Permian Period** 50 Million Years	290 Million	The first seed plants—cone-bearing trees—appeared. Fish, amphibians, and reptiles were plentiful.	 Seed Plants	Glaciers in the southern hemisphere melted and left sedimentary layers. Rocks in the northern hemisphere included limestones, sandstones, and shales. Gas, oil, gypsum, and salt formed.
	Carboniferous Period	**Pennsylvanian Period** 40 Million Years	330 Million	Algae were plentiful. Fern trees grew from seedlike bodies. Fish and amphibians were plentiful. The first reptiles appeared. Giant insects lived in forests where coal later formed.	 Reptiles	Swamps covered the lowlands. Oil, gas, and large amounts of coal formed among limestones, sandstones, and shales. River deltas partially filled the Appalachian seaway.
		Mississippian Period 30 Million Years	360 Million	Algae were plentiful and the first mosses appeared. Trilobites were dying out. Crustaceans, fish, and amphibians were plentiful. Many coral reefs were formed.	 Amphibians	Large amounts of limestone formed among layers of shale and sandstone in deltas in the Appalachian and Cordilleran seaways. Coal, gas, oil, and deposits of lead and zinc formed.
		Devonian Period 50 Million Years	410 Million	The first forests grew in swamps. Many kinds of fish, including sharks, armored fish, and lungfish, swan in the sea and in fresh waters. The first amphibians and insects appeared.	 Fish	Red sandstones, shales, and limestones formed in Europe, and black shales, reef limestones, and sandstones formed in North America. Gas, oil, and quartz sand formed.
		Silurian Period 25 Million Years	435 Million	Algae were plentiful and spore-bearing land plants appeared. Trilobites and mollusks were common. Coral reefs formed.	 Eurypicrids	Limestones, coral reefs, sandstones, and shales formed, with the deepest deposits in the Appalachian and Cordilleran seaways. Gas, oil, gypsum, iron ore, and salt formed.
		Ordovician Period 65 Million Years	500 Million	Algae became plentiful. Trilobites, corals, and mollusks were common. Tiny animals called graptolites grouped together and formed branching colonies.	 Mollusks	Greatest floods of the era covered two-thirds of North America. A delta formed in the Appalachian seaway. Gas, oil, lead, and zinc formed in limestones, sandstones, and shales.
		Cambrian Period 70 Million Years (?)	570 Million (?)	Fossils were plentiful for the first time. Shelled animals called trilobites and some mollusks were common in the sea. Jawless fish appeared.	 Trilobites	Seas spread across North America from the Appalachian seaway in the east and the Cordilleran seaway in the west. Lead and zinc formed in sandstones, shales, and limestones.
		Precambrian Time Almost 4 Billion Years (?)	4 1/2 Billion (?)	Corals, jellyfish, and worms lived in the sea about 1,100 million years ago. Bacteria lived as long ago as 3 1/2 billion years. Before that, no living things are known.	 Bacteria	Copper, gold, iron, nickel, and silver formed in shales, siltstones, lava, volcanic ash, and metamorphic rocks. The earth's crust melted and cooled repeatedly during this time.

IT'S UP TO YOU

Objective

- To understand how to solve oil pollution problems.

Exercise

Based on your expertise and knowledge from this school year, write a solution to the environmental problem below. Include suggestions about how this problem can be avoided in the future. Discuss this problem with three to four classmates and then participate in a class discussion. List ten other short-term and long-term adverse environmental problems we've encountered in this country.

What Happened?

One bright and sunny morning a large ship was on its way to deliver oil to the United States. Thirty minutes from docking at the shore the ship hit a sharp rock and a hole was punctured in its side. Before anyone knew it oil was gushing out of the hole. Eleven thousand gallons of oil poured into the ocean which many species of mammals, birds and ocean life call their home. Since the oil spill happened in saltwater the oil floated to the surface and eventually spread miles across the surface of the water.

Solution to Oil Spill

How Future Oil Spills Can Be Avoided

Short-term Problems

Long-term Problems

Effects on the Environment

Preventions

Solutions and Cleanup

Further Information

Oil can have a dramatic effect on wildlife, especially those with feathers or fur. When oil collects on the feathers or fur of animals they will soon die if not de-oiled because their coats are no longer waterproof and they cannot move properly (that is, birds can no longer fly). It is very important to clean up an oil spill quickly in order to minimize damage to the environment and wildlife. Since oil spreads rapidly on the surface of water, one quick initial cleanup solution to is to manually collect oil from the ocean's surface with a lightweight skimmer. If the oil spill is on land a powerful vacuum can be used.

MOTOR OIL

Objective

- To understand how to manage motor oil.

Exercise

In small groups discuss each topic below and explain why it is important to manage oil with care.

Topics

1. **Environmental Problems:**
   Motor oil can make drinking water toxic and prevent oxygen from dissolving in water, threatening aquatic life. Because suspended oil travels in surface storm water, pouring one gallon of used oil on the ground even miles from rivers, lakes and reservoirs can render 1 million gallons of water undrinkable.

2. **Oil Changes and a Limited Supply of Oil:**
   Vehicle and auto shop owners normally perform oil changes based on mileage and calendar schedules rather than the quality of used oil in the engine. Consequently oil changes are performed more often than necessary. If oil changes were based on oil quality testing, fewer oil changes would be required and less oil would be consumed. Since oil is non-renewable, the world's oil supply is decreasing and oil prices will inevitably rise, now is a good time to switch to changing motor oil only when it is sufficiently degraded.

3. **Importance of Oil Filters:**
   Oil filters in vehicles remove solid particles and some liquids such as fuel, water, and antifreeze from motor oil. They provide a constant cleaning process, which can safely extend oil change intervals, reduce oil use, and reduce the disposal cost of waste oil.

Note: Using a **reusable** filter that has the ability to remove smaller particles and soot is better for the engine, does not require recycling, and reduces cost to the vehicle owner.

4. **Purchase Re-refined Oil:**
   Oil does not wear out, it just gets dirty. Re-refining turns dirty oil back into fresh, "good as new" oil that can be used in vehicles. Re-refined oil is used oil that has been cleansed of contaminants and then blended with fresh additives. Re-refined oil is of equal or better quality than oil made from virgin base stock and is typically the same price or cheaper. API licensed re-refined oil must pass the same tests as virgin oil for cold start and pumpability, rust corrosion, engine wear, high temperature thickening, deposit and phosphorus.

   Re-refining used oil consumes about two thirds less energy than refining crude oil into lubricant quality motor oil. Thus, those who purchase re-refined oil not only extend the life of oil, but also increase our energy efficiency and decrease oil consumption. Thousands of different cars, trucks and fleets around the world used re-refined oil. Some users include: the State of California, the U.S. Armed Forces, Coca-Cola, United Parcel Services, Southern California Gas, Waste Management, the U.S. Postal Service, Frito-Lay, and the City of San Francisco. Re-refined oil is also used on the NASCAR race circuit.

   Re-refined oil comes in a variety of blends suitable for different types of gas and diesel engines and can be purchased in bulk from a variety of blenders (Unocal, Chevron, Safety-Kleen, Coast Oil, Rosemead Oil, Lyondell) and hundreds of independent distributors throughout the U.S. Some auto supply stores carry re-refined oil in quart containers, including Unocal's "Firebird" brand and Safety-Kleen's "America's Choice" brand. A few retailers, such as Wal-Mart and Kragen, and Good Year Service Centers carry re-refined oil.

REMOVING OIL FROM THE EARTH

Objectives

- To understand how oil is removed from the earth.
- To discuss the problems with oil removal.
- To discuss oil transportation and associated spills.

Exercise

Divide into several small groups. Each group should pick a topic from the list below, discuss it, address the question asked and provide a brief presentation of your conclusions to the class. What are the advantages and disadvantages of each topic?

Topics

1. **Oil Extraction:**
   Modern wells can be thousands of feet deep, which may cause ground-water supplies to be contaminated.

   Original oil wells only extracted about one-third of the potential oil. These methods were inefficient, which led to the development of new oil recovery techniques.

   One new technique involves pumping water into the oil reserve under pressure. The water sweeps or pushes a large portion of the remaining oil into the wells. What are the problems associated with using water to extract oil? Are they solvable?

2. **Offshore Fields**:
   Pollution problems can arise from drilling for oil in offshore deposits. Since 1947, 20,000 offshore wells have been drilled. Many of these wells leak and cause harm to the surrounding environment.

   For example, in 1969 an oil rig in Santa Barbara California leaked and caused damage to the marine habitat and recreational beaches. Another oil spill occurred in 1977, when a North Sea oil well blowout in late April caused a 20-mile oil slick.

   Lastly, in Mexico an offshore oil well blowout in 1979 contaminated Gulf fisheries and beaches with about 3.5 million barrels of oil. What effects does an oil spill have on the environment and wildlife and how can we prevent offshore oil well blowouts?

3. **Transportation and Spills:**
   Petroleum is transported by supertankers, barges, pipelines, railroad tanks cars, and highway truck tanks. Each one of these transportation methods can lead to accidents, spills, and leaks. How can these problems be prevented and what are the alternatives?

THROWING OIL IN THE TRASH #1

Objective

- To understand the effects on the environment of oil that is disposed of in the trash.

Exercise

Read the scenario and background information to answer the questions below and discuss them with two to three classmates.

Scenario

One day you are walking by your local landfill. You notice that a couple of kids are planning to throw away a can of used oil in the landfill.

With your knowledge you attempt to educate them on the disastrous effects waste oil will have on the environment.

Background

- Most municipal landfills have a protective lining underneath, to avoid soil and ground water pollution.
- Landfills give off gases as a result of decomposed wastes.
- If oil is disposed of in a landfill, it eventually seeps until it reaches the protective lining between the waste and the soil. If there is a hole in the lining, then the oil passes into the ground and eventually reaches underground water, causing contamination.

Analysis

1. What is the difference between a landfill and a dump?

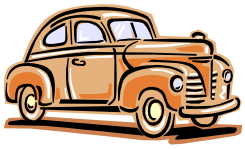
2. Why is it a problem if people discard their used oil into garbage cans that go to landfills instead of recycling it?

3. How does rain increase the chance of ground pollution?

4. What happens to an animal or a human being that drinks contaminated water?

USED OIL AND YOU

Objective



- To understand the natural resources used by a typical vehicle.

Exercise

You will learn through this activity how to use a car owner's manual to determine the natural resources a typical car might use.

Answer the following questions about one particular car:

1. Type of car (pick any car you would like to explore):_____
2. Engine Oil Capacity (quarts of new oil per oil change):_____
3. Recommended number of miles between oil changes:_____

Conversion Factors
Typical Bathtub = 30 gallons
Tanker Truck = 8,400 gallons
Typical Swimming Pool = 42,000 gallons
4 Quarts = 1 Gallon
42 Gallons = 1 Barrel
55 Gallons = 1 Drum

4. Assuming the car you have chosen is yours, use the conversion factors shown above to calculate the number of gallons of used oil you could generate in your driving lifetime. **Note**: The average person drives about 64 years of his or her life and about 20,000 miles per year.
5. Convert your answer above into drums of oil. (See example on next page.)

6. Determine how many bathtubs of used oil would be produced in your lifetime of driving this car. (See example below.)

Conclusion

- Why is it important to not waste or use more oil than necessary?

_____

_____

_____

- Gather into groups of 3-4 and discuss your findings.
- Discuss this with the entire class and teacher.

Example

1. 1983 Mitsubishi
2. 4.2 quarts of oil per change
3. 3,000 miles between changes
4. Number of gallons of used oil in your lifetime.

$$64\ \text{yr} \times \frac{20{,}000\ \text{mi}}{\text{yr}} \times \frac{1\ \text{oil change}}{3000\ \text{mi}} \times \frac{4.2\ \text{qt new oil}}{\text{oil change}} \times \frac{1\ \text{gal}}{4\ \text{qt}} = 488\ \text{gal}$$

5. Convert into drums:

$$488\ \text{gal} \times \frac{1\ \text{drum}}{55\ \text{gal}} = 8.1\ \text{drums of used oil}$$

6. Convert into bathtubs:

$$488\ \text{gal} \times \frac{1\ \text{bathtub}}{30\ \text{gal}} = 16.26\ \text{bathtubs of oil}$$

HANDS-ON ACTIVITIES

You have completed at least some of the cognitive activities and will now proceed with the hands-on activities for this course. While these hands-on activities also exercise your cognitive abilities, they require more active participation.

The hands-on activities are as follows:

A Rusty Nail
Café Reducto
Dumping Used Oil #1
Dumping Used Oil #2
Dumping Used Oil in the Backyard
Fry Guys
Fun Factory
Green Square Game
How Oil is Removed from the Earth
Making an Oil Filter
Oil Additives Help Protect Car Engines
Oil Filter Activity
Oil/Water Separator
Oily Washer
Throwing Oil in the Trash
Used Oil and Our Environment

A RUSTY NAIL

Objective

- To understand how oil affects the environment and objects in that environment.

Exercise

In this activity you will be investigating the following questions:

1. How will an iron nail be affected when it is partially submerged in water? "Untreated"
2. How will an iron nail be affected when it is coated with lubricating oil and partially submerged in water? "Treated"
3. How will an iron nail be affected when it is left exposed to air? "Air"

Materials

6 non-galvanized iron nails
Water
3 plastic lids or shallow dishes
A sample of clean oil
Steel wool or fine sandpaper

Procedure

1. Clean each of the nails with the steel wool or sandpaper.
2. Mark one of the plastic lids "treated," the second "untreated," and the third "air."
3. Dip two of the nails in lubricating oil. Place in the "treated" lid and partially submerge in water.
4. Place two other nails in the lid marked "untreated."
5. Pour water over the nails in both lids so they are wet, but not totally covered. A portion of each nail should be exposed to air.
6. Make sure both lids have the same amount of water.

7. Place the last two nails in the lid marked “air.”

8. Over the next few days observe any or all changes in each nail, such as color and shininess.

Observations:

Day 1:

Day 2:

Day 3:

CAFÉ REDUCTO

Objectives

- To apply the concept of source reduction.
- To perform a waste audit.

Exercise

This activity is designed for students who have had little previous exposure to the concept of source reduction. It is intended to teach the basics of assessing production processes to determine where waste can be reduced. Coffee-making was selected as a common process which everyone can readily comprehend and serves as a center point for discussions on how to identify source reduction options in any workplace or home process. You will learn components of waste reduction. This will be accomplished by performing a waste audit.

Process

Make some coffee. As the coffee is being made look into the “dumpster” and identify: the inputs, the process steps and the outputs. Write these down on the chart below as the coffee is being made.

Student Roles

Supplier /Vendor

You have a number of low-impact coffee processing products such as new types of filters, water, beans, and equipment which are all environmentally safe. Sure it costs more but Café Reducto customers won't object to paying a little more in doing their part to be "coffee correct.”

Environmentally Aware Customer

You want better coffee and you want it faster. You heard that they cleaned their coffee beans before roasting and wondered whether this cleaning step was needed since they were heating them up to such high temperatures anyway. You suggest that they offer a discount to customers with their own reuseable cups.

Health & Safety Conscious Customer

You want better coffee and you want healthier coffee. Knowing that some of the imported coffees may be handled a variety of times before reaching your cup you want to know what is being done to insure the cleanliness of the beans before and during processing at Cafe Reducto. You are also

concerned about their giving discounts to customers that have their own cups. Couldn't these cups transfer germs via the employees to other customers? Do they wash their hands between customers?

Cost and Time Conscious Customer

You want better coffee and you want it faster and cheaper. Why does it already cost a buck for a lousy cup? Why don't they offer a discount to customers that bring in their own cups? How come they don't have a drive-up espresso like you saw in Seattle? You don't care if the beans are clean, you won't wait for your caffeine.

Waste Handler

You mutter about increased regulations and how your costs just keep going up and how sorry you are to notify Café Reducto of yet another cost increase for your services.

Competitor

"Muddy-Less-Water Coffee Shop," you are the better, cheaper, and a more environmentally friendly shop, and you advertise these facts a lot. You use low impact everything.

County Representative

There are more and more regulations from both the State and the federal government that have to be enforced. We at the county are not to blame; we have no choice. We do have some resources that might help prevent your being subject to these regulations. I'd be glad to tell you about them.

Dr. Coffee, Owner of Café Reducto, an Academic

We have spent years perfecting the process. It is fine. Don't change the process. It's perfect. We can find secondary uses for all of the valuable byproducts generated from the coffee making process. In fact, I have a research project that is identifying ways to use the spent disposable filter-packed coffee to serve in oil spill cleanup and toxic waste spill containment. So, as you can see, there is an environmental benefit to these byproducts.

Inputs	**Processes**	**Outputs**

DUMPING USED OIL #1

Objective

- To demonstrate the effects of dumping oil on the ground.

Exercise

You will test the scenario below with the following activity.

Scenario

You ask your neighbor what he does with his used oil. He says that he dumps it down the storm drain at the end of the street.

You reply, "Isn't that illegal and a threat to public and environmental health?" "I don't think so," states your neighbor. "It's just a bit of oil, and it will become diluted when it mixes with all that water in the storm drain."

Have you ever thought about it this way? Could your neighbor be correct?

Materials

Bowl or basin
Motor oil
Talcum powder
Eyedropper

Procedure

1. Fill the basin with one-half inch of water. Let the water stand undisturbed until the water is no longer moving.

2. Sprinkle a fine layer of talcum powder over the water. The powder should be uniformly spread over the surface of the water and should not be very thick.

3. Predict what would happen if one drop of motor oil was placed in the middle of the basin.

4. Place one drop of oil on the surface of the water in the middle of the basin and describe in writing what happens.

5. Measure and record the length and width of the oil slick in centimeters. Calculate the area of the oil slick.

   Length (cm) _____ Width (cm) _____ Area (cm^2)_____

Analysis

1. Using your measurements, calculate the actual area covered by one quart of oil in square meters.

Note: 1 drop = 0.05 ml, or approximately 20 drops per ml.
1 quart of oil contains 946 ml of oil.

Area of water covered by 1 quart of oil = _____ square meters

$$\frac{cm2}{1\ drop} \times \frac{ml}{1\ qt} \times \frac{drops}{1\ ml} \times \frac{1m2}{1000cm2} = \frac{m2}{qt}$$

2. What item in the following table has an area that is closest to your results from above?

_____

Areas of common spaces

Typical parking space	17 m^2
Typical classroom	136 m^2
Volleyball court	171 m^2
Tennis court	266 m^2
Football field	4550 m^2
City block	25000 m^2

3. What would be the effect if many people dumped or leaked 1 quart of oil into local surface waters?

_____

_____

_____

_____

DUMPING USED OIL #2

Objective

- To demonstrate the effects of dumping oil on the ground and in water bodies.

Exercise

Based on the following scenario, during this exercise you will be investigating the following questions:

1. Can you tell if a contaminant is present in surface water? How?

2. Would you drink or swim in water that has a concentration of 0.5 parts used oil per 1 million parts of water?

3. What levels of oil in oceans, rivers, and lakes are considered safe for species other than humans?

Scenario

You ask your neighbor what he does with his used oil. He says that he dumps it down the storm drain at the end of the street. You reply, "Isn't that illegal and bad for both our health and that of animals?" "I don't think so," states your neighbor. "It's just a bit of oil, and it will become diluted when it mixes with all that water in the storm drain." You decide to investigate.

Materials

5 paper cups	A piece of white paper	Food coloring
Eyedropper	Distilled water	Toothpicks

Procedure

1. Number 5 cups, "1" through "5."

2. Place the cups, in order, on the white paper.

3. Place two drops of food coloring into cup 1 and add enough water to create a concentration of 1:10. Clean the eyedropper. How many drops of water did you use?

4. Remove one drop from cup 1 and place it into cup 2. Clean the eyedropper.

5. Add nine drops of water to cup 2. Stir the solution with a toothpick. What is the concentration of the mixture now? Record your data in the chart below.
6. Remove one drop from cup 2 and place it into cup 3. Clean the eyedropper.

7. Add nine drops of water to cup 3. Stir the solution with a toothpick. What is the concentration of the mixture now? Record your data in the chart below.

8. Continue with the same dilution process with cups 4 and 5. Be sure to clean the eyedropper after each dilution. Record your data in the chart below.

Data

Cup	Concentration	Parts per Million (PPM)
1	1: 10	100,000 /1,000,000
2	1: _____	_____ /1,000,000
3	1: _____	_____ /1,000,000
4	1: _____	_____ /1,000,000
5	1: _____	_____ /1,000,000

Analysis

1. How many more dilutions would be necessary to get 1 part per million (1 ppm)?

   _____

2. Is there food coloring present at 1 part per million (1 ppm)? _____

3. How do you know? _____

4. Lead can be toxic to humans at *less than* 1 part per million. How much dilution would be necessary to simulate 1 part per billion (1 ppb)?

   _____

5. Freshwater fish suffer long-term health problems in water that has a 310-ppm concentration of oil. If you had 10 liters of contaminated water containing 5,000 ppm of oil, how many liters of clean water do you think would be required to reduce the concentration of oil to 50 ppm so that it would be safer for freshwater fish? Complete the chart on the next page.

Dilution for Freshwater Fish

10 liters of 5,000 ppm + 90 liters of water = _____liters of 500 ppm water

100 liters of 500 ppm + 900 liters of water = _____liters of 50 ppm water

6. Could you safely dump the water contaminated with 50 ppm down the drain or into a lake or stream?

   _____

7. Some marine life forms suffer long-term health problems in water that has only 1-ppm concentration of oil. How could you dilute the 50 ppm water to 0.5 ppm to help avoid causing long-term health problems for ocean organisms? Complete the chart below.

Dilution for Marine Life

1,000 liters of 50 ppm + _____liters of water = _____liters of ppm water

____ liters of 5 ppm + _____liters of water = _____liters of ppm water

8. How much water is required to dilute the contaminated water to 0.5 ppm?

9. How about 1 ppb?

DUMPING USED OIL IN THE BACKYARD

Objective

- To demonstrate the effects of dumping oil on the ground

Exercise

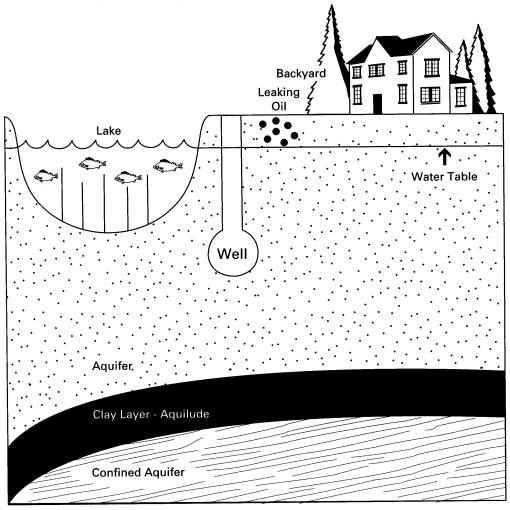
In this activity you will be investigating oil contamination.

Scenario

Your friend's father tells you to pour your used motor oil onto a patch of dirt in the corner of the yard where there are no plants growing. He says, "After all, oil occurs naturally in the ground so why not send the oil back to where it came from? Besides, it keeps the weeds from growing back there." You reply, "I don't know about that. Used oil is a hazardous waste and I'm not sure what happens to the oil after it is poured onto the soil." You decide to investigate.

Materials

Clear plastic shoebox or terrarium
PCV or similar tubing 6–10" long *
Plastic syringe *
3" square piece of cloth
Rubber band
Sand
Clay (Optional)
Eyedropper
Food coloring
Watering can (some method for sprinkling water)
6 drinking straws
Razor blade
Paper towel

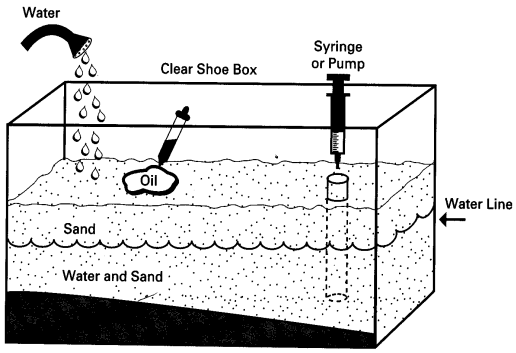


* When the syringe is inserted into the tubing, it must form an airtight fit.

Procedure, Part 1

1. Place the cloth over the end of the tubing and secure with a rubber band.

2. Assemble the groundwater model as shown in the figure to the right, pushing the tubing three-quarters of the way into the sand with the cloth end down.



3. Fill the model with water until it rises about three-quarters of the height of the sand as shown in the figure.

4. Dig a “lake” in the model deep enough to “hit” water.

5. Place the end of the syringe into the opening of the plastic tubing. A seal must form between the syringe and the tubing. Pull up on the plunger until the syringe fills with water. Record your observations. Disconnect and drain the syringe, then reconnect it.

6. Using an eyedropper, drop about 20 drops of food coloring onto the sand.

7. Sprinkle water (rain) onto the sand and wait several minutes.

8. Repeat step 5 and record your results.

Procedure, Part 2

1. One method used by geologists to study the ground is “core sampling”. From the groundwater model, remove six core samples to determine the extent of the groundwater pollution. Hold your finger over the end of the straw and *carefully* insert the straw into the sand until the straw touches the clay layer. Now, slowly pull the straw out of the sand. The sand should stay in the straw, leaving a hole in the model. A *slight* twist will help remove the straw.

2. Continue this procedure five more times at different places in the model.

3. Lay each straw on a paper towel and carefully slit the straw with a razorblade. BE CAREFUL not to cut yourself with the razor blade!

4. Record your observations on the next page.

Observations for Part 1

Step 5

Step 8

Observations for Part 2

Core #	Location of Sample	Distance from "Spill"	Description of Sample
1			
2			
3			
4			
5			
6			

Conclusions

FRY GUYS

"OUR SPUDS ARE NOT DUDS"

Objectives

- To understand pollution prevention.
- To explore waste management and source reduction.

Exercise

To strengthen your understanding of pollution prevention by exploring pollution/waste management options in a mock industrial (food processing) setting.

Background and Objectives

Your company, Fry Guys, received a notice of violation (NOV) from a State regulatory agency for hazardous waste violations for the characteristic waste (potato peels), citing too much hazardous waste. The Fry Guys plant produces french-fried potatoes and the potato peels exhibit a hazardous characteristic TCLP for lead. Your company has four (4) key goals:

1) Resolve the notice of violation (NOV) from State Regulatory agency
2) Reduce waste disposal costs
3) Improve worker health and safety
4) Improve environmental regulatory compliance

Your company's problem is its large volume of potato peel waste. Disposal requires manifesting, transport by a licensed potato peel hauler, and disposal at a permitted potato peel disposal facility. Your company has decided now to consider ways to reduce its potato peel lead problem.

Brainstorm suggestions for solutions to your company's problem while recording the ideas in the boxes on the next page. Do this for five minutes. After brainstorming, classify each suggestion as source reduction, recycling, treatment, or disposal. Briefly discuss some of the advantages and disadvantages to some of the ideas generated, particularly any advantages of source reduction proposals over other options.

Solutions

Source Reduction	Recycling	Treatment	Disposal

	Advantages	Disadvantages
Source Reduction		
Recycling		
Treatment		
Disposal		

FUN FACTORY

Objectives

- To develop communication skills in an industrial setting.
- To explore waste reduction.

Exercise

This activity, which uses a mock industrial process to illustrate waste reduction principles, is designed to give you experience in recognizing waste reduction opportunities. This includesrecognition not only of options that might reduce waste generation, but also the difficulties encountered during the implementation phase. These difficulties arise because of the natural human resistance to change, pressures of day-to-day operation of a business, and the difficulties inherent in selecting and justifying process modifications. Discovery and implementation of waste reduction opportunities relies heavily on communication, as well as technical skills. What you will discover is that even in a completely unfamiliar situation, you can make waste reduction happen by listening to the right people and asking good questions.

Positions and Job Descriptions

Plant Manager
Normally ignores the operation
Communicates customer orders to the Plant Engineer
Nods knowingly to all other inquiries
When in doubt, mumbles

Plant Engineer
In charge of handling the drums
Prepares the Play-Doh material for use in the machine
Worker complaints
Plans company Christmas party
Developing ulcers is hobby

Storage Shed Manager
Inventory control over wastes: proper labeling, proper storage, reports quantity of wastes to Plant Engineer (generally three to four months behind production)
Feels the company could save money by sending waste to brother-in-law's farm

Line Operator

Extrudes the products as ordered
Cleans up the machinery
Minimum wage (plus 10 cents per hour premium due to seniority)
Glad to have the job
Believes Elvis is still alive

Optional Positions: Depends on Number of Students at Each Table

Waste Handler

Assists the Line Operator by measuring the parts, performs cutting operation
Hands the waste to Storage Shed Manager
Minimum wage
Glad to have any job
Believes in Bigfoot

Regulatory Compliance Coordinator

Monitors the entire operation for environmental, safety, and solid waste compliance.
BS Chemistry
MS Environmental Engineering
CSP—Certified Safety Professional
CHWT—Certified Hazardous Waste Trainer

Company Policies

1. QUALITY is everyone's responsibility. Objections by anyone to the appearance, performance, or condition of any product makes that part a “REJECT.”

2. SAFETY is vital to the economic feasibility of staying in business. Unsafe acts will result in corrective counseling. Repeated unsafe acts may result in discharge.

Rules

1. This is a military specifications job; while the material is in the hands of the Plant Engineer, it may be kneaded, rolled, and “worked.” Once it is placed in the machine, it becomes either product or waste; there is no recycling or reuse of material.

2. Yellow Play-Doh is non-hazardous. Blue Play-Doh and the third color of Play-Doh are both hazardous materials. Therefore, any mixing of colors will result in a hazardous waste. (See disclaimer.)

3. Production must follow the sequence of customer orders.

Instructions

1. Set up materials for each facility and have employees decide which position they will assume.

2. Once the customer orders are received and understood, begin production.

3. Waste will be accumulated in the Storage Shed. Separate by color and type of waste. Waste will be either Quality Control Waste, Process Waste, or Cleanup Waste. Quality Control Waste is defined as any product rejected by an employee. Process Waste is waste generated in the start-up or end-of-run material. Each time production is completed, any material left in the machine will be pushed through and declared Process Waste. Cleanup Waste is any material removed from the machine during the preparation for a color change.

4. Remember, you are in competition with the other companies; time is MONEY.

5. Once you have completed production of all parts, form a Quality Circle to discuss your wastes and the improvements you made or could make during future production runs. Write these down.

Customer Orders

First:	3 Yellow Stars, made the width of a Play-Doh can lid
Second:	3 Blue Stars, made the width of a Play-Doh can lid
Last:	6 Ropes, third color, made 3 at a time, the length of a Play-Doh can w/o lid

GREEN SQUARE GAME

Objectives

- Understand the challenges and frustrations of reducing waste in an auto shop or industrial setting.
- Understand that waste reduction and its implementation does not always have commonalities with the reality of waste reduction in an industrial setting.
- Become aware of the importance of communication in waste reduction efforts.
- Become aware of the many factors that make it difficult to actually implement waste minimization, such as labor relations, customer demands, and competition.

Exercise

This activity will heighten your awareness of how waste is generated in an auto shop or industrial setting, how it can be reduced and how to apply group problem solving and communication to achieve waste minimization. In addition, you will understand how hazardous waste, even when properly disposed of, can re-enter the environment, and that landfilling or incinerating hazardous waste doesn't reduce its threat to the environment.

Purpose

To motivate you to promote, persuade, and encourage waste minimization by using business communication skills.

Instructions

1. Assemble into teams of five and sit around the "production floor" (24 x 36" paper).

2. Invent your own company name, and write the name and team members on the blackboard.

3. You will mix blue and yellow tempura paints to color a square-shaped piece of paper green to represent an unspecified "customer." Your "product" should match the model representing the customer's desired color. Paint as many squares as possible in the allotted time (so you experience the time/productivity crunch faced by all businesses.) Try to minimize the waste your group generates.

4. Any surface or object that becomes contaminated with paint, whether blue, green or yellow, becomes “hazardous.” This includes all materials, hands, clothing, table surface, and the floor. Teams will be evaluated on their ability to paint the square the correct color while generating the least amount of this “hazardous waste.”

5. You have 20 minutes to complete the activity.

6. At the 20-minute mark, the teams must stop.

7. An inspection of each team’s product and an evaluation of their efforts will follow with these criteria:

    a. Color match with the customer model
    b. Number of squares painted
    c. Production floor cleanliness
    d. Number of contaminated brushes
    e. Number of contaminated cups
    f. Number of contaminated spoons
    g. Cleanliness of back of the green square
    h. Leftover green paint
    i. Contaminated hands, clothing, etc.

8. Discussion

    a. Discuss techniques you used or could use to minimize waste generation during this activity.
    b. Solicit ideas from each company on how to dispose of the hazardous waste generated. What are your disposal options?
    c. What would happen if these toxics were incinerated?
    d. If incineration is recommended, how will you dispose of the toxic ash and deal with air pollution created during incineration? How will you prevent rainwater from becoming contaminated by incinerator pollution and consequently harming water bodies and drinking water supplies?
    e. If placing incinerator ash in a landfill is recommended, will you prevent it from leaching into the groundwater table or traveling via surface rainwater to local streams and drinking water supplies?
    f. How will you clean up the contaminated water and what should be done with the toxics removed from the water?
    g. While the volume of waste was reduced, the hazardous portion was not and is simply being moved around without being completely eliminated.
    h. What are ways to overcome this problem—how should we deal with hazardous waste generated by auto shops and other industries? Is source reduction the answer? What are the relative merits of buying

and using products from industries that become hazardous wastes but cannot be entirely removed from our environment? For homework, research one industry in your own community that generates air, water, and land pollution and determine where and how the waste from that industry is disposed.

9. Cleanup activity materials and paint drips.

Materials

Blue tempera paint (Use I teaspoon powder per team as a guideline.)
Yellow tempera paint (Use I teaspoon powder per team as a guideline.)
Four 8-oz. paper cups
Two water color brushes
Two spoons
24 x 36" sheets of white paper for production “floor" (Can be removed from flip chart.)
One 8 x 12" piece of heavy grade paper, cut into four squares
One half-full cup of water
Flip chart or blackboard
Felt-tip markers for flip chart
Chalk and erasers for blackboard

HOW OIL IS REMOVED FROM THE EARTH

Objective

- To understand how oil is removed from the earth

Exercise

Your instructor has set up the simulated oil well as shown in **Figure A**.

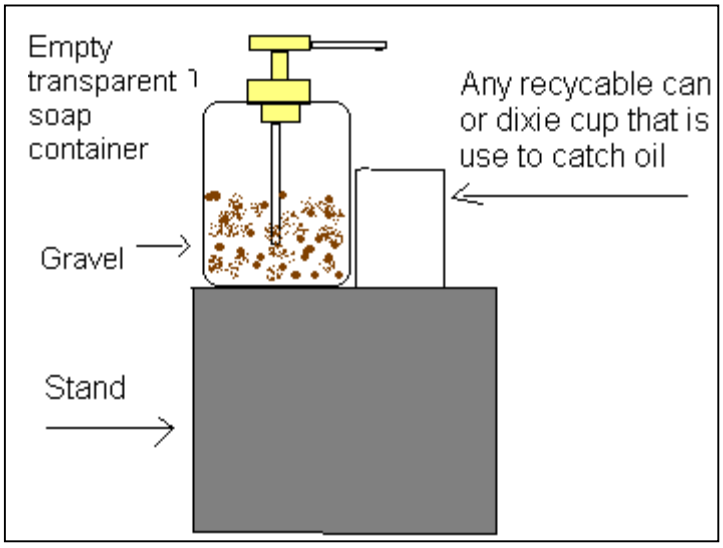


Figure A

Materials

Empty transparent liquid soap bottle with pump
Funnel
Any recyclable can or Dixie cup
50–100 ml of Oil
50–100 ml of water
Small gravel

Experiment

Fill the pump (the plastic container on top of the stand) with the small gravel half way. Then pour enough oil in the container to cover the rocks (keep track of how much oil you use).

How much of the oil do you think you will be able to remove?

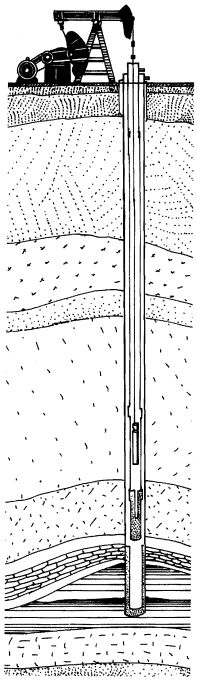
_____

Start pumping the plunger until you can no longer pump out any of the oil. Measure how much oil is in the glass container. Observe the gravel and write down your observations.

_____

_____

_____



What prevented all of the oil from being taken out of the gravel?

Research Questions

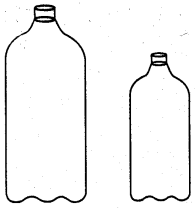
What methods are used to extract oil?

Why can't the oil companies extract all of the oil from a deposit?

How can oil removal be improved?

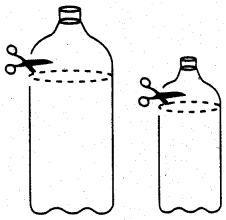
MAKING AN OIL FILTER

Objectives



- To understand how an oil filter works.
- To demonstrate an effective oil filter.

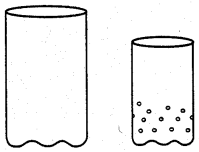
Exercise



In this activity you will be investigating the following questions:

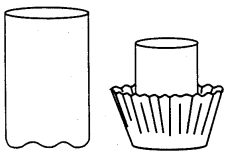
1. What substances will filter the oil most effectively?
2. What is the function of the oil filter in an automobile?

Materials

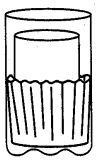


One 2-liter bottle (clear soda bottle)
One 16–20-ounce bottle (clear soda bottle)
Nail
2 coffee filters
2 rubber bands
Dixie cup
Simulated used oil: soil, dirt, vegetable oil, pieces of metal, etc.

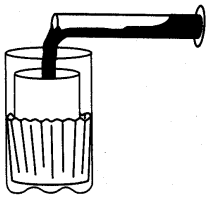
Procedure



1. Gather one 2-liter bottle and one 16–20-ounce bottle.
2. Cut the tops off of each bottle.
3. Using an nail, punch holes into the bottom of the small bottle
4. Wrap a coffee filter around the bottom of the small bottle (use a rubber band if necessary to keep the filter from slipping off of the small bottle).
5. Place the small bottle inside the larger bottle.



6. Pour 2 full cups of simulated oil into the small bottle.
7. Swirl the oil gently until all the oil has passed through the filter into the larger bottle.



8. Pour the clean oil into a Dixie cup.

9. Replace the filter and re-filter the oil that was just removed.

10. Record your observations.

Observations

Before the Oil Was Filtered	After the Oil Was Filtered Once	After the Oil Was Filtered Twice

Analysis

1. How did the appearance of the oil change after it had been filtered?

2. Were there any particles left in the filters?

3. Were the particles large or small? Why would a certain size particle be able to go through the filter?

4. What are the disadvantages and advantages of allowing particles to escape through the filter?

5. What problem would occur if the filter were not changed after each use?

OIL ADDITIVES HELP PROTECT CAR ENGINES

Objective

- To understand how oil additives work.

Exercise

In this activity you will determine how detergent additives help oil protect the engine.

Materials

2 clear glass jars (jam, mayonnaise, etc.)
Water
Liquid laundry detergent or dish soap
2 dirty, greasy samples

Procedure

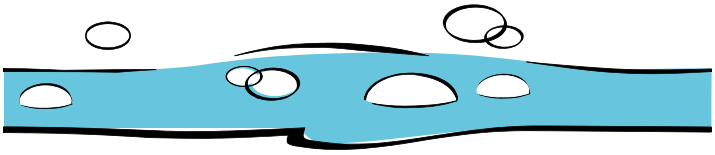
1. Label Jar 1 “treated,” and Jar 2 “untreated.”
2. Place 30 ml of water, the sample, and ten drops of detergent into Jar 1.
3. Place 30 ml of water and a similar size sample into Jar 2.
4. Place the lids on both jars and shake the jars several times.
5. Describe to either your activity partner or the group what is happening in each jar.
6. Wait five minutes, shake the jars again, and then describe them.

Analysis

1. How might detergent additives cause problems in the engine?

2. Did the detergent dissolve more grease after the first shaking or the second?

3. How might the detergents be useful in protecting a car engine when the detergent is mixed with oil?



OIL FILTER ACTIVITY

Objectives

- To demonstrate how oil is trapped in an oil filter.
- To understand the difference between hazardous and non-hazardous materials.
- To demonstrate how to properly handle, store, and dispose of used oil filters.

Exercise

1. Learn how much oil remains in an oil filter that is not properly drained.
2. Know the difference between hazardous and non-hazardous materials.
3. Understand how to properly handle, store, and dispose of used oil filters.

Background

- Each drained filter can hold between 2 and 8 ounces of used oil, while each un-drained oil filter can hold up to 1 full quart of used oil.
- Once the filter is removed from the car it is considered hazardous waste. This is due to the accumulation of lead and various metals from the engine.
- For a filter to be considered non-hazardous it needs to be drained of all free-flowing oil. The oil should drain for about 12 hours.
- After the oil is removed, it should be placed in a rainproof container (capable of holding 55 gallons in an auto shop).
- Used oil filters that are removed from the auto shop should be sent to a facility permitted to recycle oil filters.
- Note that 14 million oil filters are sold annually in California.

Safety Tips

- Wear gloves to prevent skin contact with contaminated used oil.
- Wear safety goggles to protect eyes.

- Used oil filters are considered toxic to your health, as well as to the environment.

- Properly store the used filters to make recycling easier.

Activity #1

As your instructor takes a new oil filter and cuts it in half with a hacksaw, observe all the different areas in which used oil is retained inside the filter when it is not properly drained.

- Discuss the potential hazards to the environment from used oil filters that are not properly drained.

- Discuss potential reuses for the metals and oil recycled from used oil filters.

Activity #2

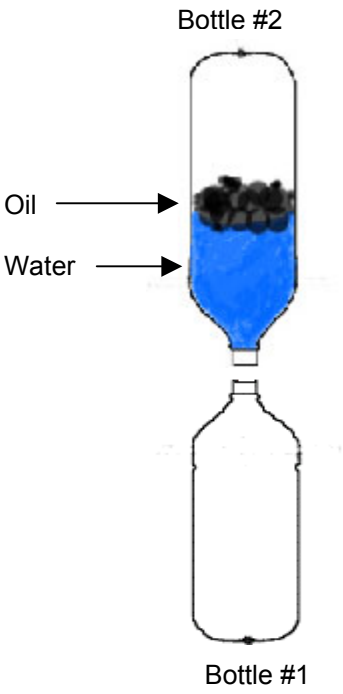
To demonstrate how much oil a filter that is not properly drained retains, remove a used oil filter from a vehicle and pour used oil from the filter into a recycle container for 30 seconds. Place the partially drained filter upside down on a 2 to 4 quart-measuring cup. Wait 24 hours and observe how much oil has drained out into the measuring cup.

- Discuss the potential environmental damage that could occur from thousands or even millions of un-drained or poorly drained used oil filters that are improperly disposed.

OIL/WATER SEPARATOR

Objective

- To understand how an oil/water separator works.



Exercise

You will investigate the separation of oil, water, and dirt before disposal.

Materials

Dirty oil
Soil
Water
Two 2-liter soda bottles
Coffee filter
Funnel

Procedure

1. Take one 2-liter bottle (#1) and fill the bottle one-quarter full with water and add a handful of soil and then add 1 cup of oil.

2. Place the cap on the bottle and shake it vigorously.

3. Take the second bottle (#2) and place the funnel with a coffee filter in it into the top of the bottle.

4. Slowly pour all the contents of bottle #1 into bottle #2.

5. Drill a hole in the cap of bottle #2 and screw the cap onto the bottle #2 which now contains a filtered mixture of water and oil.

6. Wait 10 minutes for the water and oil to separate into two layers.

7. Wash bottle #1 with soap. This bottle will be used for collection of the filtered water.

8. When the oil and water layers are separated in bottle #2, slowly turn it upside down and match the neck to the bottle #1 so the bottles are touching neck to neck (see figure above).

9. When just the water layer is transferred to bottle #1, stop the flow. We have now separated soil, oil, and water from each other.

Analysis

Answer the following questions based upon the results of the experiment.

1. If there were contaminating materials in the water and the water was not filtered, how would it effect our environment?

2. If nothing was filtered from auto shop wastewater but it went directly into oceans, lakes, and streams, how would that effect wildlife and our environment?

3. Why is it a good idea to separate oil from water?

4. After the water and oil are separated would it be easier to dispose of the oil?

Discussion

Wastewater ends up in one of three places:

1. Storm Drains: Water flows untreated from storm drains directly to creeks, streams, lakes, bays, and oceans. If the water is contaminated, it can harm aquatic life and land-based life that drinks and bathes in water.

2. Septic Systems: Discharge to septic systems can cause soil, ground water and drinking water contamination, creating site cleanup liabilities and public health hazards.

3. Sanitary Sewers: Hazardous wastes that enter sewers leading to water treatment plants contaminate sludge and prevent its beneficial use.

OILY WASHER

Objectives

- To promote, persuade, and encourage the substitution of aqueous for solvents parts cleaning in the auto shop or other industrial setting.
- To understand the challenges, frustrations, and barriers to substituting aqueous cleaners for organic solvents in an industrial setting.
- To demonstrate the importance of group communication during efforts to change parts-cleaning policies in industrial settings.

Exercise

This activity will heighten your awareness of the challenges and benefits of exchanging aqueous cleaners for solvents. At the same time, it will provide you with a sense of what it's like to work in an industrial setting and to use group problem-solving techniques.

Instructions

Assemble into teams of five, each team seated around a parts-cleaning tray.

Each individual will be given oily steel washers to clean along with three different cleaning solutions. After 20 minutes, the instructor and other teams will evaluate how fast you cleaned the oil from the washers, and afterwards, how clean and
dry your washers are in comparison to the instructor's model of a clean, dry washer.

Individual team members will also evaluate the efficacy of the three cleaning solutions after doing the timed cleaning activity. You will be asked to develop evaluation criteria and document how effectively each cleaner removed oil from the washers by making notes on each one.

Each team will develop and write down evaluation criteria to rank individuals' washer cleanliness. Each team will subsequently evaluate how effectively individuals on other teams cleaned their washers. Each team should record other teams' washer cleaning criteria and other teams' evaluations of their own members' washer cleanliness.

Team Activity Guidelines:

In an industrial setting, one individual has used organic solvents to clean 50 washers per minute, delivering them dry outside of the solvent. You are expected to meet this standard.

Use the pre-prepared trays containing cleaning equipment. You will have 20 minutes to complete the activity.

At the 20-minute mark teams must stop cleaning parts.

Once the activity stops, the individual and subsequent team evaluations take place for the next half-hour.

Next teams should look at the flip chart that shows the cost of each cleaner. Note the cost of the cleaners and debate the merits of each cleaner within your team for another 15 minutes. Jointly decide which is the best cleaner. Be ready to explain what cleaner you've chosen and why.

Next, how do you determine whether the washers are clean? To answer this question, refer back to the different teams' criteria and evaluations of how well you cleaned the washers.

The instructor has a test to determine if the washers are/are not clean and will now check the washers and evaluate your cleaning efforts.

Discussion:

a. How would you solve the washer drying time problem and what is your estimate of the costs of correcting this problem?

b. How would you set a quality standard that results in oil-free washers? Would this standard vary, depending on the cleaning solution used?

THROWING OIL IN THE TRASH #2

Objective

- To understand the effects on the environment of oil that is disposed of in the trash.

Exercise

You help some friends change the oil in their car. They want to pour the used oil into old milk containers and throw them into the trash can. In their opinion, the sanitation company gets paid to take care of these things, so why not let them deal with it? You reply, "But what will happen to the milk containers and oil in the landfill?" You decide to investigate.

Materials

Two 2-liter soda bottles
Food coloring
Water
Gravel
Soil
Organic Matter

Procedure 1—Preparing the Bottles

Cut the bottles as directed below, referring to the landfill model diagram.

1. The base: Make an incision 2 cm below the shoulder of Bottle #1 and cut off the top; retain top and bottom.

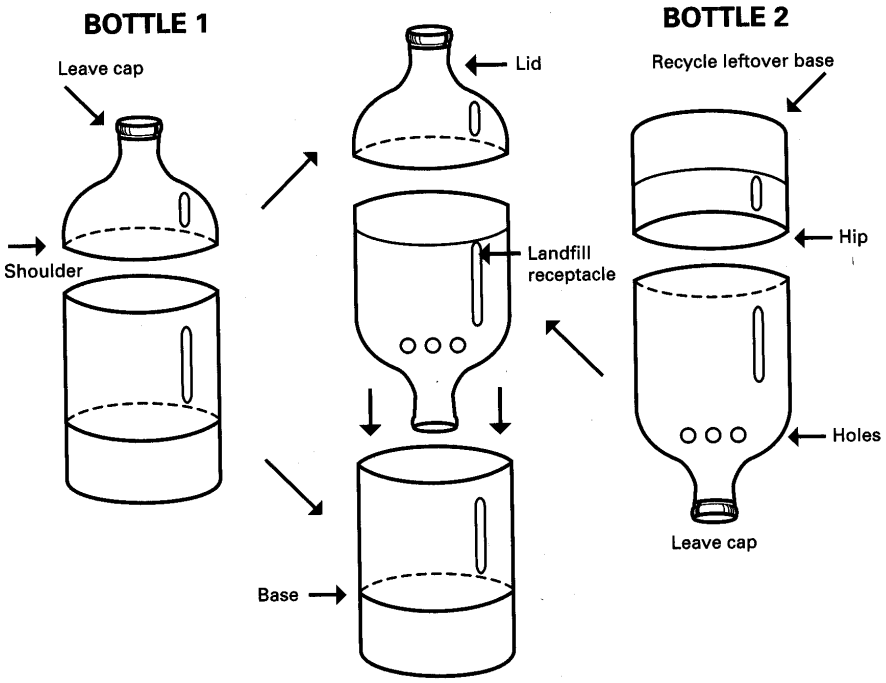
2. The landfill receptacle: Make an incision 2 cm below the hip of Bottle #2 and cut off the base.

3. Recycle the base.

4. The sieve: Puncture the neck of Bottle #2 with a red-hot skewer, making 6 to 10 small holes.

5. Insert the inverted sieve tightly into the base from Bottle #1 and secure with tape. The tape must be secure but removable.

6. The lid: Use a 3-cm piece of tape to hinge the cut top from Bottle #1 to the top of the receptacle.

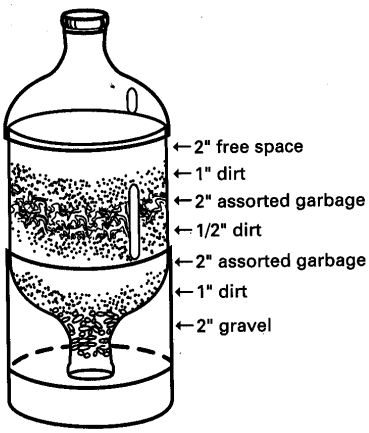


Procedure 2—Building the Landfill Model

1. After construction, ask your instructor to check your landfill model for possible adjustment.

   Note: If you are adding a liner, be sure to attach the lining to the landfill container before adding the layers.

2. To build the landfill, remove the top of the model landfill and build layers of gravel, soil, and organic matter in the model, as shown in the diagram below. Be sure that the top layer is soil. Reattach the top of the model.



Finished Landfill Model

Procedure 3—The Experiment

1. On the first day, drop about 3 drops of blue food coloring on the top of the soil to represent used motor oil that has leaked out of decomposed or crushed containers into the landfill.

2. Measure 100 ml of tap water.

3. Gently pour 100 ml of water into the landfill to simulate rainwater.

4. Store your landfill model in a dark place and keep it damp to simulate actual landfill conditions.

5. On the second day of this investigation, carefully lift the top of the model off of the base. Describe the water from the landfill (leachate). What color is it? Does it have any odor? Do you see anything that would indicate used motor oil in the leachate? Record your data in the chart below.

6. Repeat steps 2, 3, and 4.

7. On the third day, carefully lift the top of the model off of the base. Describe the water from the landfill. What color is it? Does it have any odor? Do you see anything that would indicate used motor oil in the leachate? Record your data in the chart provided.

Data

	Leachate—Date	Leachate—Date	Leachate—Date
Observed Changes			

Analysis

1. Predict what will happen to your landfill after four days, after two weeks, and after one month.

2. Assuming that you continued to add 100 ml of water at the same time intervals, predict what will happen to the simulated used oil after four days, after two weeks, and after one month. Explain.

3. What happens to rainwater that falls on the landfill?

4. If the liner of a landfill were to fail, how might the groundwater be affected by the contaminated leachate?

5. What could happen if an animal ate discarded food from the landfill that had come into contact with the leachate?

Conclusions

1. What would happen if many people continued to place containers of oil in their trash?

2. Based on this investigation, write a fact-based statement to explain to your neighbor why it is the general public's responsibility to not dispose of used oil in the trash can but to recycle it instead.

USED OIL AND OUR ENVIRONMENT

Objective

- To understand the effects of oil pollution on the environment.

Exercise

In this activity, you will investigate how the environment is harmed by oil pollution.

Materials

2-liter container, clear
One Dixie cup of sand
Two Dixie cups of soil
Water
Oil (motor or vegetable)
A small plant either found outside with roots still attached, or purchased from a nursery

Procedure

1. Cut the tops off the containers to allow for planting the plants.
2. Fill the sand and the soil into the bottom of the 2-liter containers, until the contents are about one-quarter of the container.
3. Place the plant into the center of the sand and soil mixture.
4. Add enough water to give the soil and sand mixture a moist texture. Observe mixture and make notes.
5. Put three to four drops of oil around the plant and on the leaves.
6. Mix the soil carefully around the plant so the oil is allowed to seep into the roots.
7. Wait overnight and then observe the plant and its roots by taking the plant from the soil and laying it on a paper towel.
8. Compare your results to your instructor's plant that was not exposed to oil.

Observation

Before Placing the Oil into the Soil	24 Hours After Placing the Oil onto the Plant	Plant Without Oil

Analysis

1. Was there a difference between the plants that were exposed to oil versus the plants that were not?

2. What were the differences?

3. What would happen to the plants in our environment if an oil spill occurred on land?

4. Is it a good idea to regulate oil wells?

5. If oil companies did not have any regulations for digging, what would change about our environment?

USED OIL RECYCLING

Objective

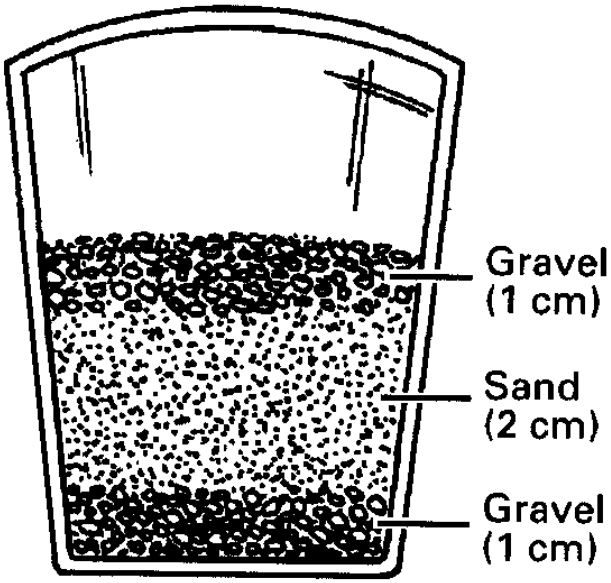
- To understand how oil can be recycled.

Exercise

In this activity, you will investigate how contaminants can be removed from used oil.

Materials

Approximately one-half cup of used oil
Paper cup (Dixie cup)
Paper clip or straight pin
Gravel
Sand



Procedure

1. Straighten out the paper clip and then use it to poke holes into the bottom of the paper cup.

2. Place approximately 1 cm thick layer of gravel into the cup. Add 2 cm layer of sand on top of the gravel. Add another 1 cm layer of gravel on top of the sand.

3. Observe the color, odor and presence of solids in the used oil before it is filtered.

4. Gently pour the sample of used oil into the cup. Make sure to catch the filtered oil in another container as it comes out of the holes in the paper cup.

5. Observe once again the color, odor, and presence of solids in the used oil after it is filtered, taking note of any changes.

6. Dispose of the used sand, gravel, and oil according to your teacher's instruction.

Discussion

In groups, discuss the questions below:

1. How did the sand act as a filter?

2. How would your results have been different if you had used:

   Finer sand?

   Coarser sand?

   A deeper layer of sand?

3. How is sand similar to a paper filter in the way it separates a mixture?

4. Did you achieve the results you expected? If not, explain why your results deviated.

5. How can contaminants be separated from used oil?

6. What could you do with the solid materials that were filtered out of the used oil?